

CLAIMS

1. A composite antenna device comprising:

a ground board;

an unbalanced antenna including

5 a first feeding point coupled with the ground board,
 a first radiator having a first end and a second end, the
first end of the first radiator being connected with the first feeding point,
 a load conductor connected with the second end of the
first radiator; and

10 a balanced antenna including

 a second feeding point,
 a second radiator connected with the second feeding
point, and
 a third radiator connected with the second feeding
15 point,

 wherein the load conductor has a shape symmetrical about a
straight line which passes through the first feeding point and which is
perpendicular to the ground board, and

 wherein the second radiator and the third radiator are placed at
20 positions symmetrical to each other about the straight line, respectively, and
have shapes symmetrical to each other about the straight line.

2. A composite antenna device comprising:

a ground board;

25 an unbalanced antenna including

 a first feeding point coupled with the ground board,
 a first radiator having a first end and a second end, the

first end of the first radiator being connected with the first feeding point, and
a load conductor connected with the second end of the
first radiator;

a balanced antenna including

5 a second feeding point,
a second radiator connected with the second feeding
point, and
a third radiator connected with the second feeding
point,

10 wherein the load conductor has a shape electrically symmetrical
about a straight line, the straight line passing through the first feeding point
and being perpendicular to the ground board, and

wherein the second radiator and the third radiator are placed at
positions electrically symmetrical to each other about the straight line,
15 respectively, and have shapes electrically symmetrical to each other about
the straight line.

3. A composite antenna device comprising:

a ground board;

20 an unbalanced antenna including

a first feeding point coupled with the ground board,
a first radiator having a first end and a second end, the
first end of the first radiator being connected with the first feeding point, and
a load conductor connected with the second end of the

25 first radiator;

a balanced antenna including

a second feeding point,

a second radiator connected with the second feeding point, and

a third radiator connected with the second feeding point,

5 wherein the load conductor has a shape symmetrical about a plane, the plane passing through the first feeding point and being perpendicular to the ground board, and

 wherein the second radiator and the third radiator are placed at positions symmetrical positions each other about the plane, respectively, and
10 have shapes symmetrical to each other about the plane.

4. A composite antenna device comprising:

a ground board;

an unbalanced antenna including

15 a first feeding point coupled with the ground board,
 a first radiator having a first end and a second end, the first end of the first radiator being connected with the first feeding point, and
 a load conductor connected with the second end of the first radiator;

20 a balanced antenna including

 a second feeding point,
 a second radiator connected with the second feeding point, and

 a third radiator connected with the second feeding
25 point,

 wherein the load conductor has a shape electrically symmetrical about a plane, the plane passing through the first feeding point and being

perpendicular to the ground board, and

wherein the second radiator and the third radiator are placed at positions electrically symmetrical to each other about the plane, respectively, and have shapes electrically symmetrical to each other about the plane.

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5. A composite antenna device comprising:

a ground board;

an unbalanced antenna including

a first feeding point coupled with the ground board,

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a first radiator having a first end and a second end, the first end of the first radiator being connected with the first feeding point, and

a load conductor having a connection point where the load conductor is connected with the second end of the first radiator;

a balanced antenna including

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a second feeding point,

a second radiator connected with the second feeding point, and

a third radiator connected with the second feeding point,

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wherein the load conductor of the unbalanced antenna includes a first portion and a second portion, the first portion of the load conductor being provided between the first end of the load conductor and the connection point, the second portion being provided between the second end of the load conductor and the connection point, and

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wherein an impedance Z_{11} of the first portion of the load conductor, a mutual impedance Z_{12} of the second radiator to the first portion of the load conductor, a mutual impedance Z_{21} of the first portion of the load

conductor to the second radiator, an impedance Z_{22} of the second radiator, an impedance Z_{33} of the second portion of the load conductor, a mutual impedance Z_{34} of the third radiator to the second portion of the load conductor, a mutual impedance Z_{43} of the second portion of the load conductor to the third radiator, and an impedance Z_{44} of the third radiator satisfy the relation of

$$\begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix} = \begin{pmatrix} Z_{33} & Z_{34} \\ Z_{43} & Z_{44} \end{pmatrix}.$$

6. The composite antenna device of claim 5, wherein a mutual impedance Z_{14} of the third radiator to the first portion of the load conductor, a mutual impedance Z_{41} of the first portion of the load conductor to the third radiator, a mutual impedance Z_{23} of the second portion of the load conductor to the second radiator, and a mutual impedance Z_{32} of the second radiator to the second portion of the load conductor satisfy the relation of

$$\begin{pmatrix} Z_{11} & Z_{14} \\ Z_{43} & Z_{44} \end{pmatrix} = \begin{pmatrix} Z_{22} & Z_{23} \\ Z_{32} & Z_{33} \end{pmatrix}.$$